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ABSTRACT

A model has been developed for studying the relation between text structure and reading comprehension, emphasizing the reader's use of world knowledge and text-structural knowledge to evaluate and interpret meaning from text. When the highlights of the model are considered from the perspective of various expository texts used in research on comprehension theory, two features indicate the utility of using expository texts in research on prose comprehension. First, expository texts are far less constrained in structure than typical narrative texts. As a result, a thorough explanation of expository comprehension will require a detailed investigation and description of bottom-up, text-driven reading processes. Second, expository texts offer a direct link to questions of learning. That is, most expositions identify and explain concepts that are new to the reader and that should be incorporated into the reader's knowledge structures as a result of comprehending the text. (RL)

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A knowledge-based model of prose comprehension: Applications to expository texts

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Virtually all of the research on prose comprehension in recent years has been focused on three topics:

1: How the meaning of a text is represented in memory.

2: The processes that are responsible for deriving that representation from a text.

3: How these processes are affected by a reader's prior knowledge about the world and about text structure.

Researchers have shown substantial agreement on these questions. Almost all comprehension models use some sort of propositional system to represent the meaning of a text; most models also assert that a reader's knowledge about the world and about the structure of texts as rhetorical devices plays an important part in the success and efficiency of the comprehension process. There is still room for disagreement despite this general consensus, and some of the most heated arguments have been about the relation between text structure and comprehension. The model that Walter Kintsch and I have been developing addresses these three issues, including that of text structure, and I hope to use this model and the texts we are considering today to comment on these questions of comprehension and text structure.

Our model has as its foundations the text comprehension theory of Kintsch and van Dijk (1978); we have in recent months been concentrating on the knowledge-based component of the model. The basic characteristics of this model are:

1. The content of a text can be expressed by a set of propositions, each of which identifies some basic idea presented in the text.

2. There are two general classes of processes. Microprocesses are responsible for identifying local coherence relations among a text's propositions, producing a fairly literal representation of the text's structure. Macroprocesses are responsible for finding conceptual interpretations for text-propositional structures, and constructing macropropositions; these are structurally similar to text propositions, but describe the text's global meaning. These processes are highly interactive: microprocesses organize text propositions into surface-level structures for which a conceptual interpretation is sought, and macroprocesses use the reader's conceptual knowledge to identify meaningful relations that may not be explicitly stated in the text's surface structure.

3. The construction of these representations is presumed to take place in a working memory structure that is limited in capacity. As a result, the size of the propositional and macropropositional structures maintained in working memory must be limited. The model therefore processes a text in a number of cycles, working on a single sentence or phrase during each cycle, and special strategies are used to interconnect the representations of these sentences and phrases. These restrictions are important not only because of the structural capacity limitations, but also because macropropositions are used to direct the interpretation of text-propositional structures.

Having too many macropropositions in working memory would actually impair comprehension, by offering too many potential interpretations for a text segment.

4. The macroprocessing component is highly dependent on the reader's knowledge structures, which can be classified into two types. World knowledge is used throughout the model's processing to evaluate the propositional content of the text. These evaluations can often be based on the predicate of the proposition being interpreted: to verify the proposition corresponding to "John threw the ball", the model must determine that, in case frame terms, the agent doing the throwing must be living, and the object being thrown must be relatively small; these restrictions exclude sentences such as "The ball threw John" or "John threw the building".

The model's second use of knowledge is in the application of text-structural knowledge to the search for an appropriate interpretation of a text. For instance, consider the text:

> "John was in a big hurry to get to work this morning. As he was hurrying down the stairs, he slipped on his son's skateboard, fell down the stairs, and broke his leg."

The fact that "...and broke his leg" is an acceptable continuation of this text is due to the interaction of two pieces of knowledge: the world knowledge that falling down a flight of stairs can lead to an injury such as breaking a leg, and the text-specific knowledge that, after an action is stated in a text, the result of that action is also likely to be mentioned.

This kind of knowledge could easily be represented in the form of a text grammar, although this model places less emphasis on such structures than do traditional text grammar systems (Mandler & Johnson, et al): here, text-structural knowledge merely serves as an additional source of constraint on the comprehension process (cf. Rumelhart, 1980).

We are currently instantianting this theory as a computer simulation model. One problem with this methodology is that applying the model to a totally new text is not an easy task, as a significant amount of world knowledge specific to that text must be added to the model's knowledge base. Hence, we have not actually applied the model to any of the texts being discussed today but our own. It is, however, both possible and worthwhile to consider the highlights of the model from the perspective of these expository texts.

The first important difference between expository and narrative texts is that the structure of an expository text is constrained to a far lesser degree than is the structure of a narrative of comparable difficulty. When we read the "Old Farmer" story (Thorndyke, 1977):

> "One evening, the farmer was trying
> to put his donkey in its shed..."

and, perhaps more importantly, when we know that we are reading a goal-oriented story, we can assume that the text will probably continue by describing what the farmer did to achieve this goal. The search for a meaningful interpretation of the following

sentences can then be constrained by assuming that they describe the farmer's attempt to solve this problem. Such limitations are not generally possible in expository texts; this lesser degree of constraint is particularly well-illustrated in Meyer's text about oil spills. The text begins by describing a problem, which is the focus of the text:

"A problem is prevention of oil spills from supertankers."

After this initial sentence, we encounter a description of a supertanker, a further specification of the problem, the result of the problem, two examples of the problem, another result, and a cause of the problem -- all in the first paragraph! Unlike narrative texts, there is little in the structure of an expository text that will offer top-down guidance in the interpretation of these segments -- there is no particular reason that Meyer's text should continue by describing a supertanker than by giving an example of the problem being discussed, and there is no a priori reason to think that either continuation would be easier to understand. Some limited help might be available from within-sentence linguistic structures such as subject or object positioning and passive focusing, and from the explicit marking of the text segments (e.g., "The solution to the problem is that ..."). In general, however, the comprehension of expository texts seems to be much more bottom-up than that of narratives.

A similar problem can be seen in Graesser's text: many of the sentences in this text could be rearranged with few ill effects. One restriction is evident: at the end of the paragraph, the phrase,

"However, until the Middle Ages, the wagons were..."

would seem to signal that the text will continue by describing how wagons were different after the Middle Ages (as it does). This kind of comparative construction may be one of the few sources of constraint available in expository texts, and even this is based more in linguistic sentence structure than text structure.

Mayer's "Radar" text illustrates the importance of comparing text segments to knowledge structures at all levels of the comprehension process, and of building new knowledge structures during comprehension. The concepts being described in the text are explained in terms of other, preexisting concepts (e.g., radar waves are like water waves), and the reader must be able to access and modify these well-understood concepts in order to fully comprehend the text. This text then emphasizes, as do most expository texts, the question of learning; in terms of our model, how and when are these modified knowledge structures integrated with prior knowledge? This is an area that has not been studied nearly as much as it should be, and we hope to apply our model to this question in some depth in the future.

Frederiksen's and Voss's texts are much closer to narratives than the other texts we have considered today. However, a sound model of expository comprehension should ideally be extendable to narrative comprehension, through the addition of assorted relevant knowledge structures -- for instance, strategies for achieving goals and solving problems. These two texts illustrate some important aspects of such a system.

First, the reader must have meta-cognitive control over much of the comprehension process. In these texts, it is necessary to relax, suspend, or alter certain processing strategies: Voss's text can be read and understood in spite of our knowledge that animals cannot really talk. Similarly, we can impose our knowledge of what children can and cannot do upon Frederiksen's text, and properly comprehend a conversation that would be inappropriate for an adult.

Second, these texts emphasize that comprehension often takes place at several different levels. Frederiksen emphasizes the conversational, narrative, and problem solving aspects of his text; it is almost certainly the case that our knowledge about and understanding of each of these levels of comprehension facilitates the other. Kintsch and van Dijk (1978) have discussed how reading goals might be represented as part of a comprehension model, but this text demands that several goals be pursued simultaneously. Similarly, multiple macroprocessing strategies must be pursued in Voss's text: the immediate problems and goals of the characters in the text must be understood at the same time as the more complex, almost

metaphorical, set of ideas about helpfulness and leadership. Deriving the proper representations of the knowledge structures and processes necessary for the comprehension of these texts would be an an admirable goal for any comprehension model.

Let me close by summarizing the two features of expository texts that, I believe, make them especially useful for studying comprehension. First, the expository texts we have considered today are far less constrained in structure than are typical narrative texts. As a result, a thorough explanation of expository comprehension will require a detailed investigation and description of bottom-up, text-driven processes. The second useful feature of expository texts is that they offer a direct link to questions of learning: most, if not all, expositions identify and explain concepts that are new to the reader and that should be incorporated into the reader's knowledge structures as a result of comprehending the text. These are phenomena with which we are all concerned, either from psychological or educational perspectives, and I have found that expository texts offer a particularly rich domain for the study of these problems.